Chapter Forty-five

EXPRESSWAYS
(New Construction/Reconstruction)

BUREAU OF DESIGN AND ENVIRONMENT MANUAL

Chapter Forty-five
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EXPRESSWAYS
(New Construction/Reconstruction)

Expressways are functionally classified as Other Principal Arterials and are constructed with partial control of access. Expressways are intended to provide high efficiency, safety, and move high volumes of traffic at high speeds. The operational efficiency, capacity, safety, and cost of the highway facility are largely dependent upon its design. Intersections are an integral feature of an expressway design. Chapter 45 provides guidance in the design of expressways including specific design criteria, frontage roads, median openings, service drive connections, public road connections, and transitions. Information that is also applicable to expressways is included in the following chapters:

- Chapter 11 discusses the design of expressway alignment and profile.
- Chapter 14 discusses intersection design studies.
- Chapter 15 discusses interchange type and design studies.
- Chapters 31, 32, 33, 34, and 39 provide guidance on the geometric design elements that are also applicable to expressways.
- Chapter 35 provides guidelines on the access control around interchanges and intersections on expressways. It also discusses the procedures for preparing access control plans.
- Chapter 36 provides information on the design of intersections including left- and right-turn lanes, channelization, and intersection sight distance. Certain alternative intersection types can often be considered along expressway facilities; see 36-1.03(b).
- Chapter 37 discusses the type, location, layouts, and design of interchanges.
- Chapter 38 provides guidelines on roadside safety issues.
- Chapter 44 discusses the procedures for designing freeways, which require full control of access. New-alignment expressway bypasses may include sections with full control of access.

45-1 GENERAL

45-1.01 Design Studies

Chapter 11 discusses the procedures for determining the location of expressways within a corridor. Factors that determine an expressway alignment include:

- existing roadway alignment (many rural expressways will involve constructing a travel way adjacent and parallel to an existing two-lane highway);
- logical and effective locations for proposed interchanges;
- locations of structures over railroads, streams, and river crossings;
- access control along the expressway and crossroads at interchanges and intersections;
- access to property and right-of-way restrictions;
- topography; and
- environmental restrictions.

45-1.02 Establishing An Expressway

When a highway is designated and designed as an expressway, the district must prepare and file an Order Establishing a Freeway sometime after receiving design approval but before construction plans are finalized. The details of this procedure are discussed in Chapter 12. The Order must include the access control limits along the mainline, the location of access breaks for field and private entrances, and the limits of access control along each crossroad.

In addition to filing an Order Establishing a Freeway, the district should also consider filing a Corridor Protection Map. The procedures for this process are described in the *Land Acquisition Policies and Procedures Manual*.

45-1.03 Crossroads

With expressways crossroads usually remain open and are designed as intersections, but also consider opportunities to relocate lower-volume routes. At some locations, a grade separation and/or interchange may be proposed at a crossroad. The following Sections provide guidance for making these decisions.

45-1.03(a) Interchanges/Intersections

For rural expressways, full-access or alternative-access intersections are provided with most public crossroads. When reconstructing urban expressways, limit the number of such connections and space them according to Section 45-2.06(b). Chapter 36 provides the design criteria for intersections that are also applicable to expressways.

Accurate traffic projections based on reasonable estimates of local and regional growth are very important in the planning of expressways. Over-estimation of growth may result in excessive right-of-way acquisition for unnecessary interchanges; underestimation of growth can create future operational concerns at the at-grade intersections. Interchanges may be constructed or planned at state marked routes or high-volume county highways. Apply the following guidelines in decision making:

- Consider constructing an interchange initially where traffic signals are expected to be warranted within nine years of construction.
- Where projected traffic volumes show a warrant for traffic signals within 10 to 20 years, initially provide a traditional or alternative intersection. Depending on the analysis of future operations, consider a design that can be adapted to accommodate a future interchange. This will include purchasing the access rights for approximately 1000 ft to 1200 ft (300 m to 350 m) along each leg of the crossroad.
- If traffic signals are not warranted within the 20-year design life, construct a two-way stop-controlled traditional or alternative intersection.
- Where a low-volume marked route exists within 2 miles (3 km) of another parallel marked route or high-volume crossroad, consider relocating the low-volume route and only provide one interchange to serve both routes.

Signalized intersections along high-speed roadways can create safety concerns in part because drivers do not expect them. Therefore, when an interchange is not appropriate, a two-lane roundabout should be considered when signal warrants are met at any time within the 20-year design period. Consider the safety of all users in assessing a two-lane roundabout design option wherever two-way stop control will not be effective in handling projected traffic volumes and where local constraints or costs make an interchange impractical. Although roundabouts will increase travel time slightly versus a free-flow mainline condition, the resulting safety benefits as well as operational improvements for side road traffic and non-motorized users can often be substantial.

45-1.03(b) Grade Separations

Grade separations should be considered at all railroad crossings, sites where terrain contours favor the separation of grades, and at high-volume crossroads near an urbanized area where the crossroad connects with a marked route.

45-2 GEOMETRIC DESIGN FEATURES

45-2.01 Design Speed

Figures 45-4.A and 45-4.B provide the range of design speeds for expressways between 50 mph (80 km/h) and 70 mph (110 km/h). Most expressways are classified as rural and will have a 70 mph (110 km/h) design speed. Existing geometric design features may be allowed to remain in place in accordance with Section 45-2.02. For additional guidance on selecting design speeds for existing facilities, see Chapter 49 and consider the following:

- whether a new or existing alignment is proposed for the expressway,
- access restrictions and the level of access control that can be achieved,
- whether signalized intersections will be required initially or in the future, and
- construction costs.

45-2.02 Alignment

Expressways should have smooth-flowing horizontal and vertical alignments. Proper combinations of curvature, tangents, grades, and median types all combine to enhance the safety and aesthetics of expressways. When designing expressway alignments, consider the following:

1. Horizontal Alignment. In rural areas, use curve radii which yield consistent superelevation (SE) rates in the range of 3-4%. SE rates in this range are efficient, meet driver expectations, and minimize the design challenges at intersections/entrances.

   Also design alignments to avoid SE transitions on bridges or bridge approach slabs. In urbanized areas where right-of-way is restricted, it may not be practical to avoid SE transition on bridges. See Section 32-3.07 for guidance on the location of horizontal curves near bridges.

   Existing horizontal curves may remain in place provided they have a comfortable operating speed within 10 mph (15 km/h) of the design speed if there is no historical pattern of crashes within the curves. See Section 49-3 for guidance on comfortable operating speeds.

2. Vertical Alignment. For the vertical alignment, use design values in the “desirable” range to produce a smooth, aesthetically pleasing alignment. For existing alignments, the following will apply:

   a. Sag Vertical Curves. Existing sag vertical curves may remain in place if they have a design speed within 20 mph (30 km/h) of the design speed if there is no historical pattern of crashes.

   b. Crest Vertical Curves. Existing crest vertical curves may remain in place if they have a design speed within 15 mph (25 km/h) of the design speed if there is no historical pattern of crashes.

3. Horizontal and Vertical Combinations. Consider the relationship between horizontal and vertical alignments simultaneously to obtain a desirable condition. Chapter 33 discusses these relationships and their effect on aesthetics and safety.

45-2.03 Typical Sections

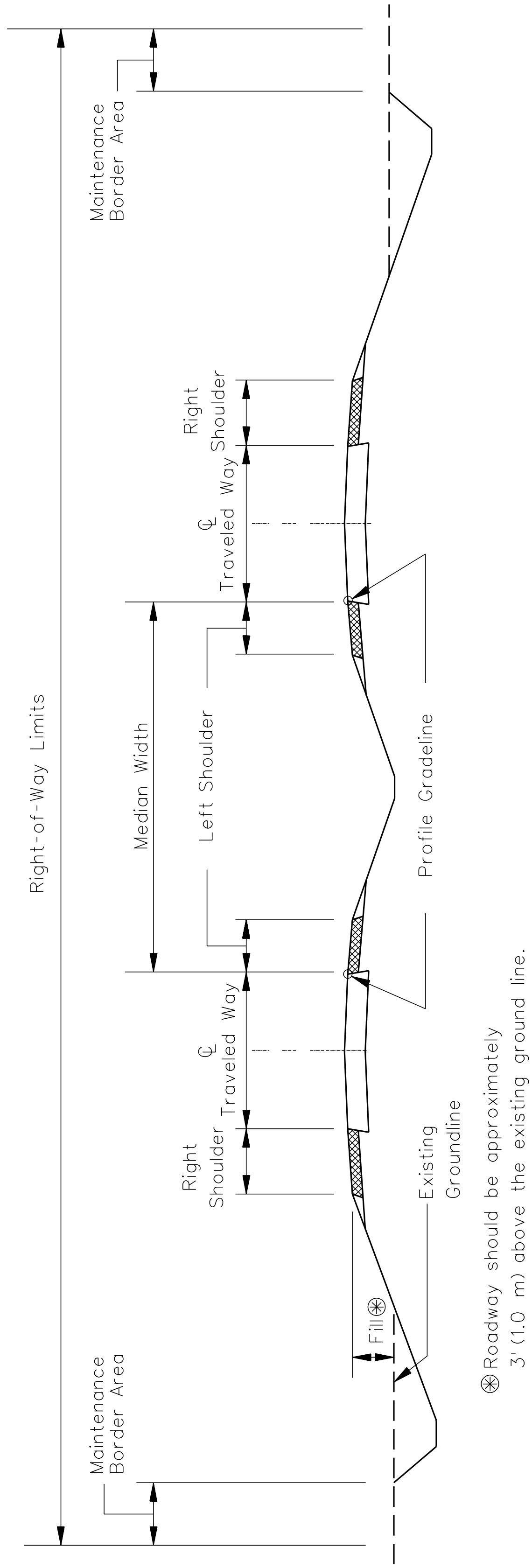
The tables in Section 45-4 provide the minimum criteria for lane widths, shoulder widths, median widths, and other cross section elements that should be used on expressways. Figures 45-2.A through 45-2.E illustrate schematic typical sections for various expressway designs.

45-2.04 Access Control

Access to expressways must be located at points that will enable vehicles to enter and exit without creating undue safety concerns. The controls governing the location of access points have some degree of flexibility to meet traffic needs, to fit terrain features, and to be cost effective. Locating access points must be done within the purpose and intent of partial access control. As part of locating access points designers must address safety performance and operational concerns with a goal of allowing mainline traffic to flow without excessive delay.

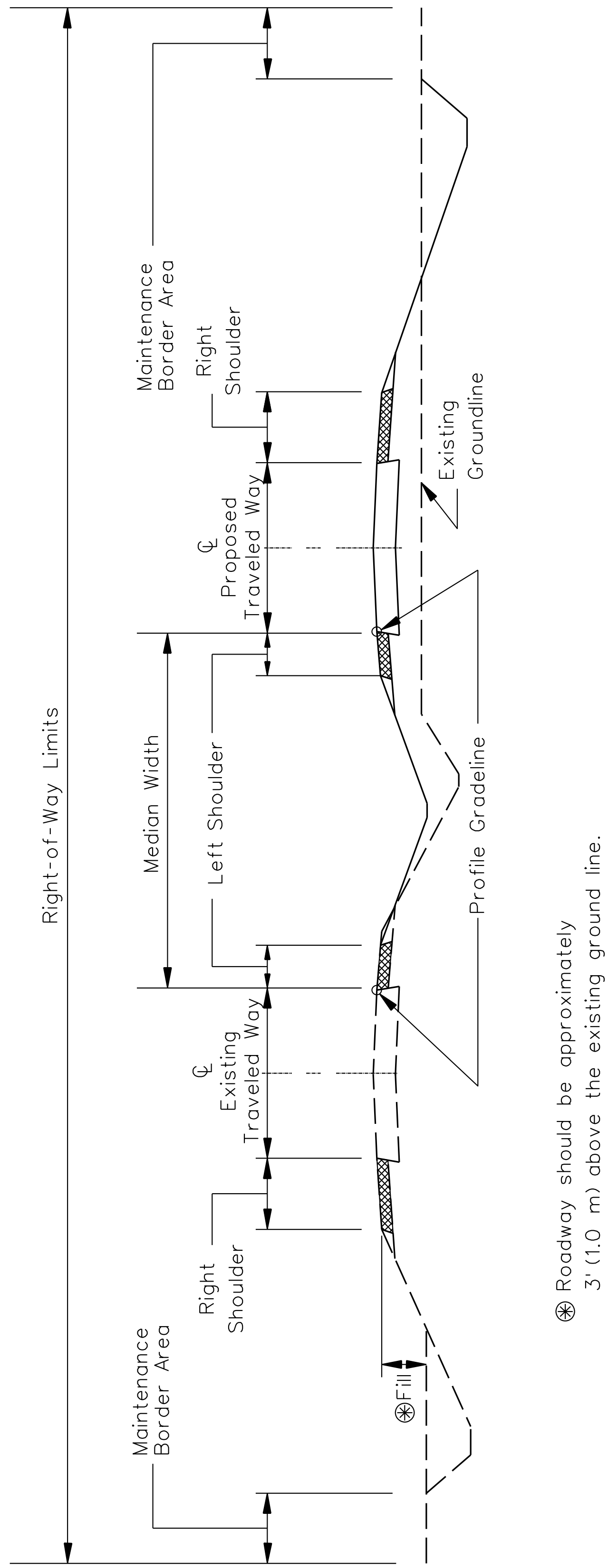
The types of access allowed on expressways (e.g., partial control, full control on new bypasses, entrances) are discussed throughout Section 45-2 and Chapter 35. Any major access changes should be discussed at district coordination meetings with both BDE and FHWA. When expressways are not on the National Highway System (NHS) exceptions to Department access criteria are reviewed and handled by BDE.

Chapter 35 provides the procedures for preparing access control plans during Phase I studies.



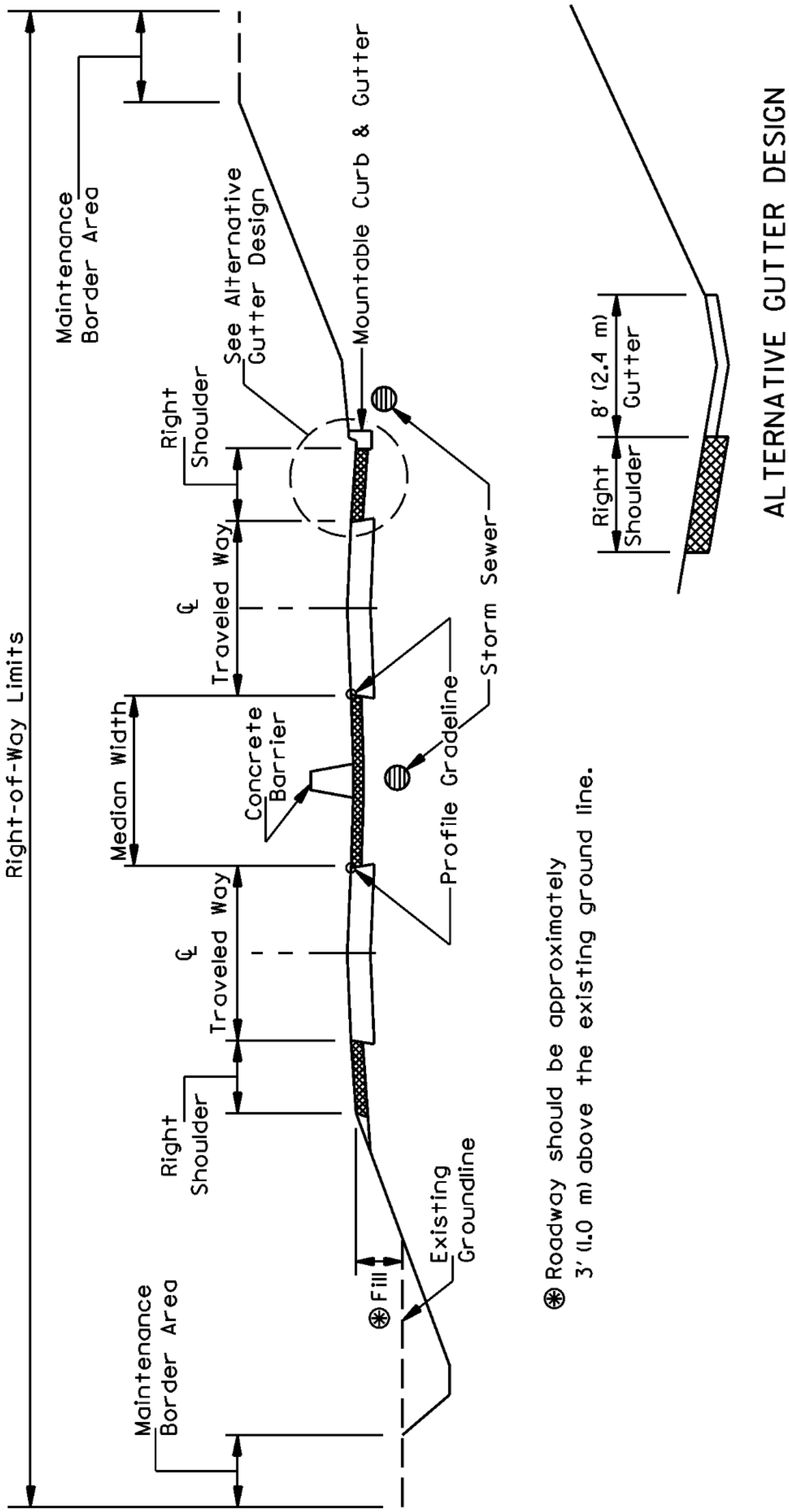
TYPICAL SECTION FOR RURAL EXPRESSWAY
(New Alignment)

Figure 45-2.A



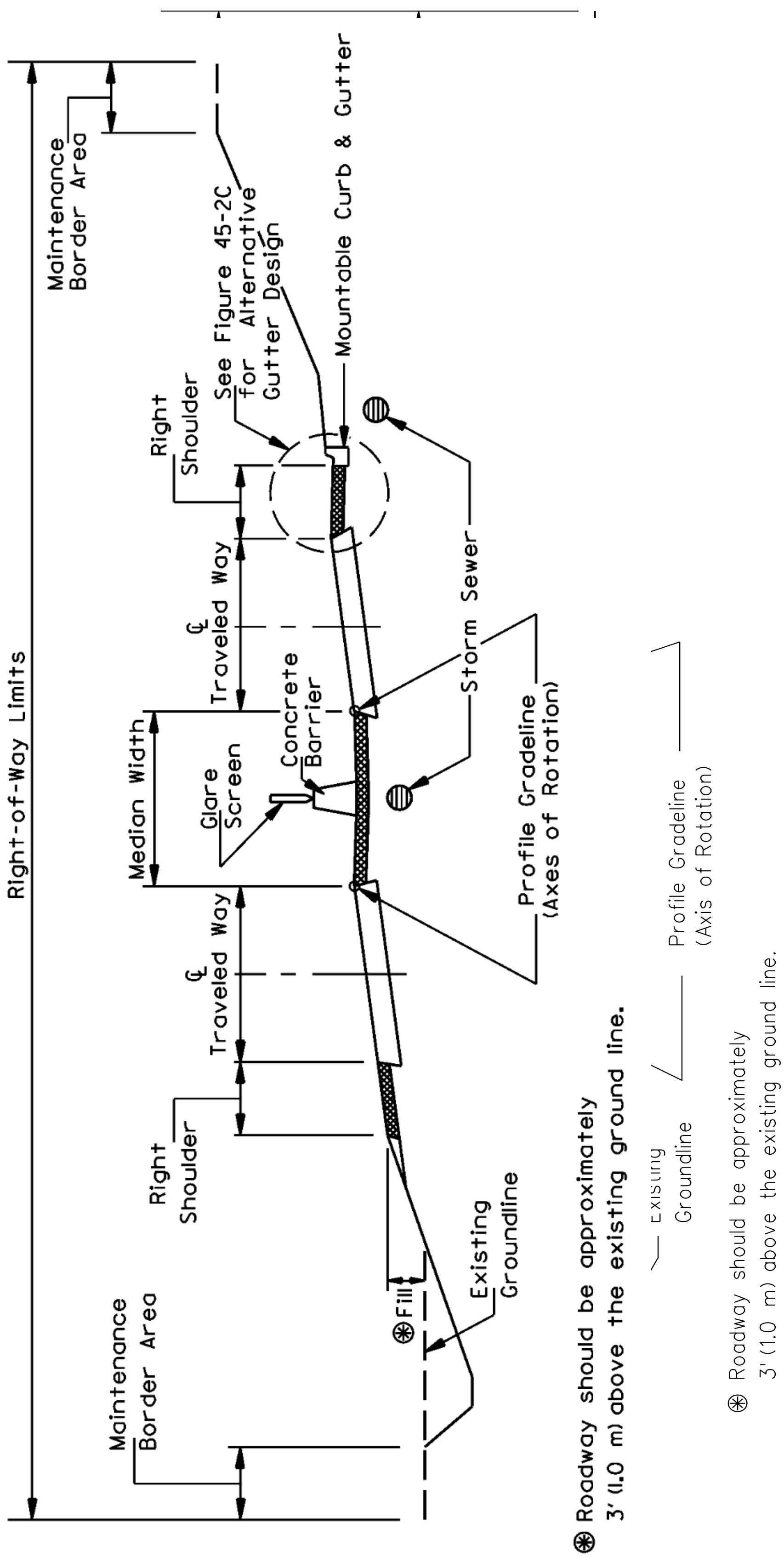
TYPICAL SECTION FOR RURAL EXPRESSWAY USING EXISTING ROADWAY

Figure 45-2.B



TYPICAL SECTION FOR URBAN EXPRESSWAY
(Flush Median with Concrete Barrier)

Figure 45-2.C



TYPICAL SECTION FOR SUPERELEVATED EXPRESSWAY
(Flush Median with Concrete Barrier)

Figure 45-2.E

45-2.05 Intersections

Chapter 36 provides the criteria for the design of intersections. In addition, the following will apply to expressways:

1. Definitions. The following definitions will apply to the crossroad:

    a. Major Public Roads. These are facilities with ADT's of 1500 or greater.
    b. Minor Public Roads. These are facilities with ADT's less than 1500.

2. Turn Lane Warrants. In addition to the turn lane warrants presented in Section 36-3.01, the following will apply to expressways:

    a. Left-Turn Lanes. Provide left-turn lanes at all public road intersections and at any other locations where U-turns regularly occur.

    b. Right-Turn Lanes. Provide right-turn lanes at all major public road intersections and at minor public road intersections where the ADT is greater than or equal to 250. At minor public road intersections where the ADT is less than 250, the use of right-turn lanes will be determined on a case-by-case basis.

3. Tapered Offset Left-Turn Lanes. For the design of tapered offset left-turn lanes, see Section 36-3.03(c).

4. Parallel Left-Turn Lanes. For the design of parallel left-turn lanes without an offset, see Section 36-3.03(b). Safety concerns arise with this type of design if they could create visibility constraints with opposing left-turning traffic.

5. Signalized Intersections. Signalized intersections on expressways typically are used only in urban and suburban areas. Due to the safety concerns presented by their "unexpected stop" conditions other options should always be considered. Provide interchanges where traffic signals are warranted; see Section 45-1.03(a). Also investigate alternative intersection designs that may best address operational and safety concerns; see Section 36-1.03(b).

6. Superelevation of Intersections. See Section 36-1.05(b) for intersection details on curves.

7. Design Speeds. In rural areas, use a 70 mph (110 km/h) design speed to design turn lanes on the expressway at major public road intersections and a 50 mph (80 km/h) design speed for turn lanes at minor public roads. In urban areas, use the mainline design speed, typically 50 mph (80 km/h) and also consider storage requirements to determine overall turn-lane lengths.

8. Lighting. Consider providing partial lighting at all major intersections. See Chapter 56 for information on highway lighting.

45-2.06 Medians

45-2.06(a) General

Expressway medians should be as wide as economic, operational, and environmental considerations will permit. Consider the following in the design of medians:

1. Median Selection. Section 34-3 discusses the purpose of medians, types of medians, and guidelines for their selection. Rural expressways generally will have depressed medians. In more urbanized areas where right-of-way is restricted, flush medians with concrete median barriers are typically used. Raised curb medians may only be used where design speeds will be 45 mph (70 km/h) or less, so they are rarely used along expressways.

2. Widths. Section 45-4 provides the minimum median width criteria. The designer should note the following:

   - Median widths of at least 50 ft (15 m), and preferably 64 ft (19 m), are recommended where a large number of trucks are turning or crossing.

   - In rural areas, median widths of 100 ft (30 m) or more may be appropriate when using independent alignments and based on engineering or aesthetic goals. These wider medians accommodate two-stage left turns and typically will not create operational or safety issues if well signed and marked.

   - Provide minimum 50 ft (15 m) wide medians where school buses may store within the median when performing left turning and crossing movements.

3. Median Openings. Section 36-4.04 provides the criteria for designing and laying out the median openings (crossovers) that are provided for full access intersections.

4. Median Barriers. Within narrow medians where the design speed is greater than or equal to 50 mph (80 km/h) a median barrier is required between the directional roadways. See Section 38-7 for guidelines on median barriers. Also, see Figure 36-3.M for how to terminate a median barrier at intersections.

5. Illustrations. Figures 45-2.A and 45-2.B illustrate a typical depressed median. Figure 45-2.C illustrates a typical flush median with a concrete median barrier.

45-2.06(b) Access and Crossover Spacing and Design

Paved median openings (crossovers) for U-turns, crossing and full-access entering/exiting movements along expressways should be constructed only where operationally necessary and where adequate sight lines can be provided. Initial and future crossover locations should be discussed and determined, to the extent practicable, during project planning stages and shown in a Phase I report. Provide the minimum number of median openings necessary to serve the existing road network during the initial construction. Additional crossovers may be considered later as the need arises. In addition to crossovers at many township roads, most county highways, and most State highways, crossovers may also be considered:

- to permit full access to and from frontage roads and public service drives;
- to minimize the adverse travel from agricultural or residential entrances;
- where property, held under one ownership and used for farming, is severed by an expressway, and;
- to accommodate U-turn movements, often in conjunction with RCUT or other alternative intersections. Where U-turns are expected, median widths of less than 64 ft (19 m) will require the inclusion of outside “loon” areas to allow for tractor-semitrailer movements.

Space median crossovers on expressways according to the following:

1. Rural New Alignment. Space median crossovers, including those for intersecting public highways, an average of 1 mile (1600 m) as measured between adjacent intersections. However, closer spacing may be provided for severed farm tracts.

2. Rural Existing Alignment. Where the new roadway is constructed parallel and adjacent to the existing highway, the average crossover spacing may be reduced to ½ mile (800 m). A detailed study and analysis should document any recommendation to reduce the average spacing to ½ mile (800 m).

3. Urban New Alignment. Where a rural expressway is extended into an urbanized area and where a bypass alignment is feasible, design the bypass with full control of access. This eliminates cross traffic conflicts, stopping through traffic due to traffic signals, lower running speeds, and the potential for rear-end and right-angle crashes.

4. Urban Existing Alignment. Where an expressway design has been extended from a rural area through a developing urban area with restricted right-of-way and where reconstruction of an existing arterial is proposed to six lanes, space median crossovers on the average ¼ mile to ½ mile (400 m to 800 m) apart. Where reconstruction of an existing arterial is proposed to four lanes, space median crossovers no closer than 500 ft (150 m) and desirably 1320 ft to 1800 ft (400 m to 550 m) apart. At these distances, consider closing some median openings and only allowing right in and right out on the side street. Signalized intersections will exist and signal progression must be considered and investigated for the above designs.

5. Interchanges. The location of the first median crossover beyond the end of an interchange entrance ramp terminal will be dependent on the design speed of the expressway. See Chapter 35 for the applicable spacing criteria.

6. Near Bridges. Do not locate crossovers within 750 ft (225 m) of overhead bridge structures or within 750 ft (225 m) from the ends of mainline bridges. Provide adequate stopping sight distance on each side of the proposed crossover.

45-2.07 Future Public Road or Street Connections

Chapter 605 ILCS 5/8-107 of the *Illinois Highway Code* allows the Department, county, or municipality to give, withhold consent, or fix conditions on any request for connecting a new highway or other public way to an expressway. When reviewing a request for public road connections to an expressway, consider the following:

1. Applications. Permit applications must be presented by and issued in the name of the local public agency that will be responsible for the maintenance of the facility upon completion of construction. For a determination of financial responsibilities with public road connections, see the Department's *Joint Agreements Policy and Procedure Manual*.

2. Spacing. Limit the connections according to the median crossover spacing requirements noted in Section 45-2.06.

3. System Design. Evidence must be presented that the proposed public road or public service drive will become an integral part of an existing or definitely planned public road system. The access should not be merely a provision for internal circulation within a particular property.

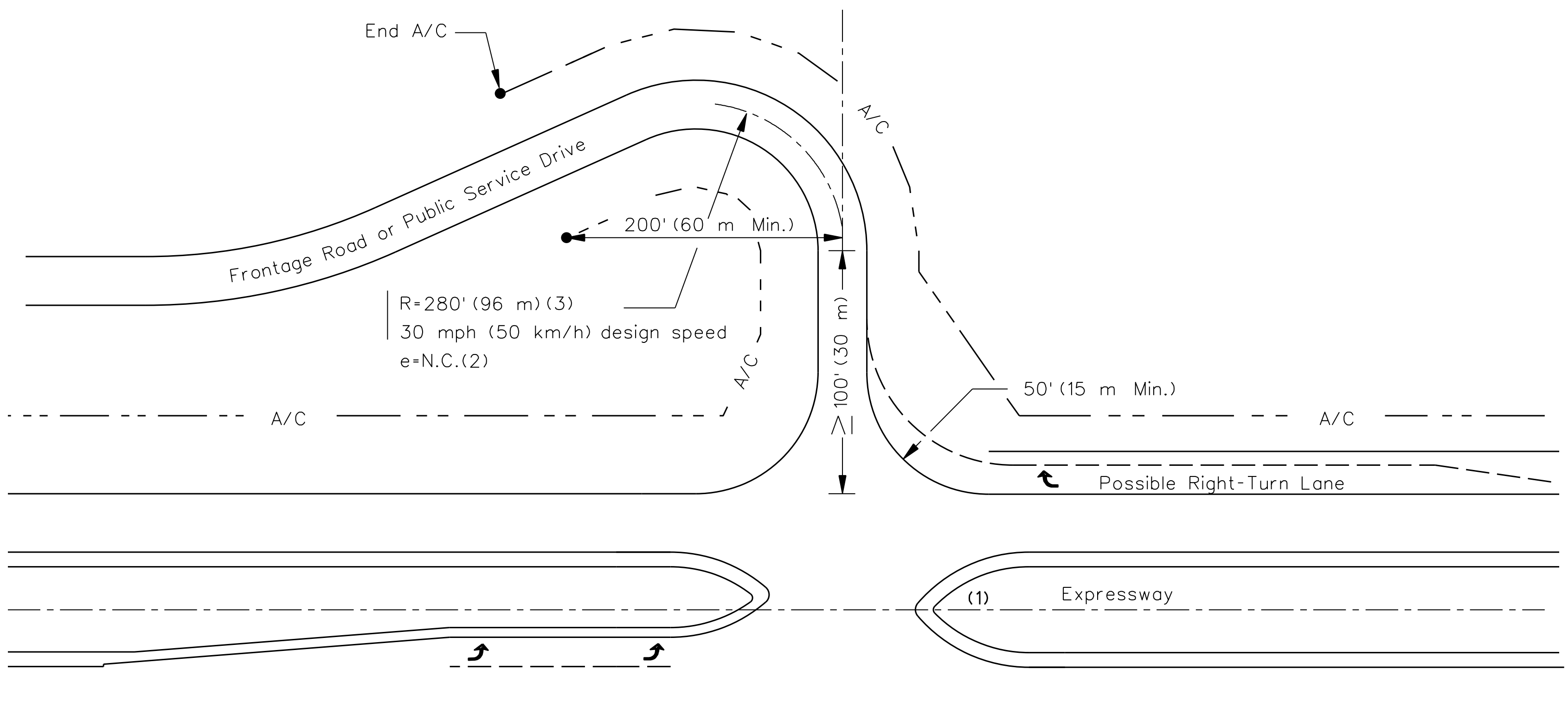
4. Access. See Chapter 35 to determine location of the first point of access allowed along a proposed new connection. According to the *Illinois Highway Code,* the Department is authorized to define these first points of access adjacent to an expressway considering safety and traffic operations.

45-2.08 Frontage Roads/Service Drives

Access to expressways from frontage roads and public service drives is only permitted opposite median crossovers and should be designed according to Figures 45-2.H and 45-2.I. Space median crossovers according to Section 45-2.06(b). For expressways, the following definitions apply:

1. Frontage Roads. A public street or road normally located alongside of and parallel to an expressway. Its purpose is to maintain local road continuity and to provide for access. A frontage road is connected to public roads or streets at both ends. In some cases, it may be connected to a public road at one end and the expressway at the other.

2. Service Drive. Similar to a frontage road except that a service drive is normally connected to a public road or street at only one end. A private service drive is one that is maintained by the property owner(s) served.



Notes:

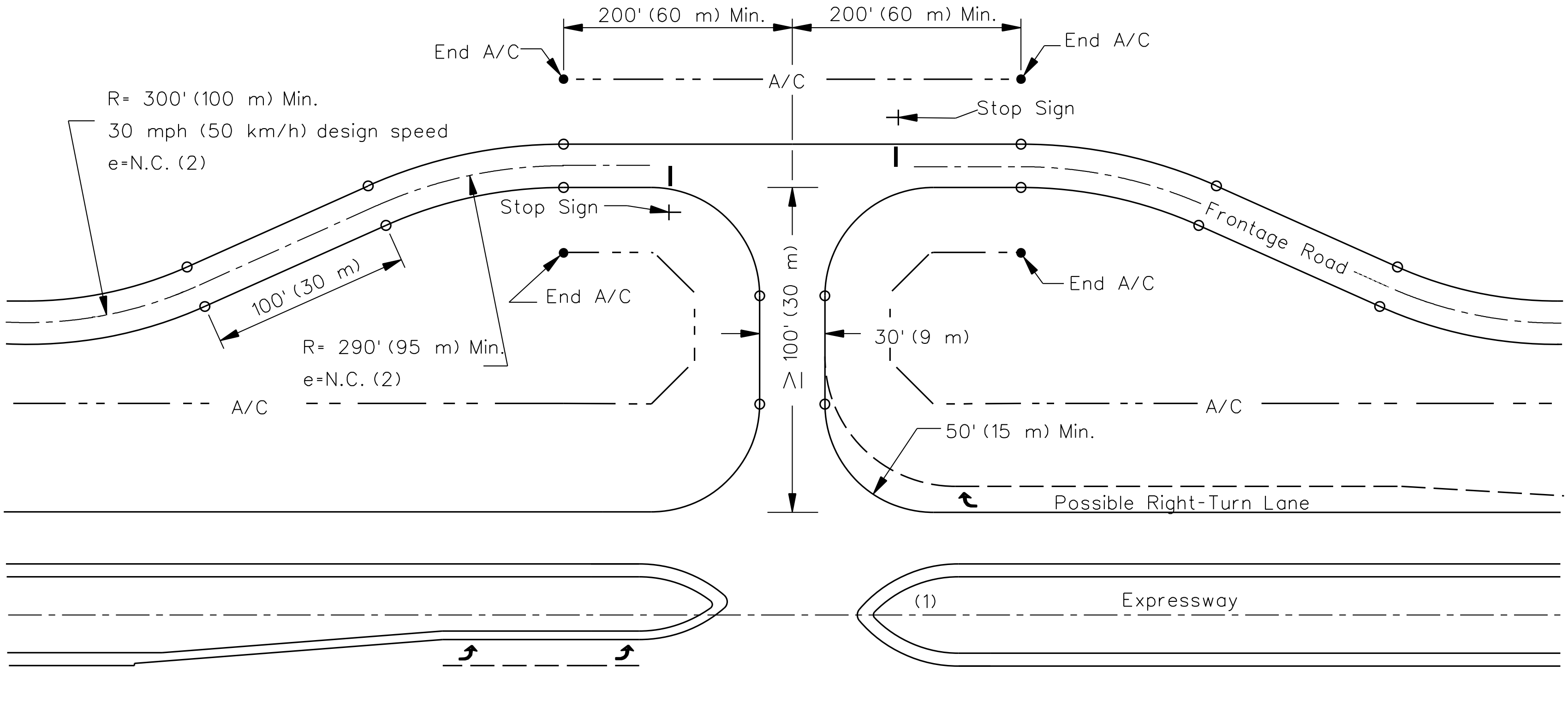
1. *With a median crossover as shown typically include a left turn lane. There may be a need to add a loon area for U-turn movements opposite the left-turn lane.* Considerations in determining design details include *the expected number of U-turns per day, safety, and the level of service on the expressway in the design year.*

2. *Use AASHTO Method 2 for the distribution of superelevation on curves; see Section 48-5. Normal crown is 3/16″ /ft (1.5%).*

3. *If physical space is not available to provide a 280 ft (96 m) radius, use as large of radius as practical, but not less than the minimum radius required for the selected design vehicle. If the radius is selected for the design vehicle, widen the pavement through the curve to accommodate the design vehicle.*

TYPICAL FRONTAGE ROAD OR PUBLIC SERVICE DRIVE DESIGN AT AN ACCESS POINT

Figure 45-2.D



Notes:

1. With a median crossover as shown typically include a left turn lane. There may be a need to add a loon area for U-turn movements opposite the left-turn lane. *Considerations in determining design details include the expected number of U-turns per day, safety, and the level of service on the expressway in the design year.*

2. *Use AASHTO Method 2 for the distribution of superelevation on curves; see Section 48-5. Normal crown is 3/16″ /ft (1.5%).*

TYPICAL FRONTAGE ROAD DESIGN AT AN ACCESS POINT

Figure 45-2.E

The design criteria for frontage roads and public service drives adjacent to freeways as presented in Section 44-2.05 also applies to these facilities along expressways. In addition, Figure 45-2.J illustrates a cross section view with a service drive adjacent to an expressway where restricted right-of-way conditions exist.

45-2.09 Entrances

45-2.09(a) Agricultural and Residential Entrances

Direct access may be provided to an expressway from an abutting property if it is used solely for farming purposes or for one single-family residence. For these locations, only consider points of direct access where other means of access require unreasonable adverse travel, have excessive construction costs or damages, and where the point of direct access will not interfere with the operational safety of the expressway. Agricultural and single residential entrances are subject to the following specific restrictions:

1. Interchanges. See Chapter 35 to determine the required spacing of an entrance from the end of the speed change taper of an interchange ramp. The calculated composite distances are also provided in Chapter 35.

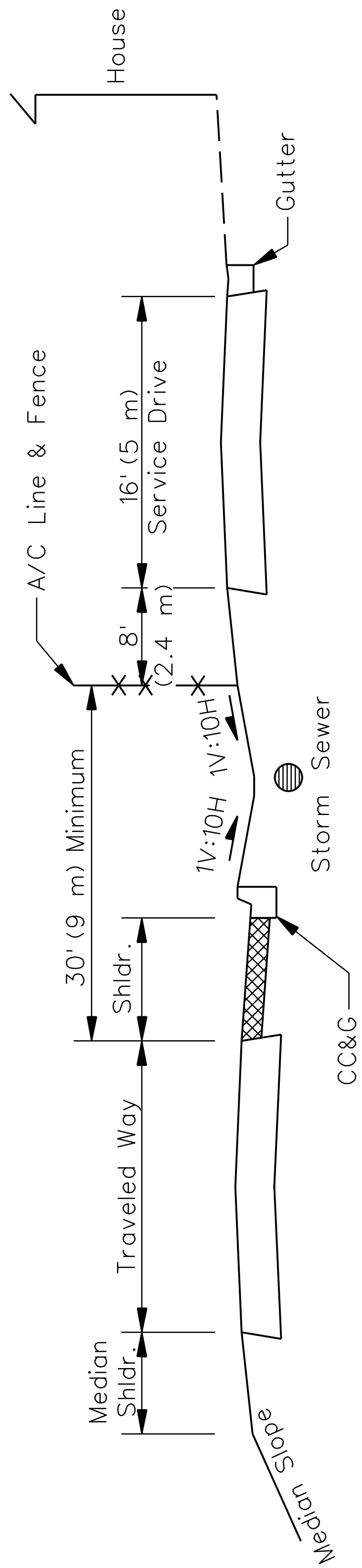
2. Median Crossovers. Do not provide an entrance within 300 ft (90 m) of a median crossover if the entrance is not located directly opposite the crossover.

3. Number and Spacing. Limit the number and spacing of agricultural or residential entrances to a desirable average of one per ¼ mile (400 m) on each side of the expressway. The minimum distance between two residential entrances on the same side of an expressway should be 500 ft (150 m). Where practical, consider combining two or more entrances into one service drive.

4. Field Entrances. Where a field entrance exists to an agricultural property and where the property extends to a nearby public road, make every effort to relocate the field entrance to the adjacent public road.

5. Suburban Entrances. In rare cases, additional entrances to an expressway can be approved on a case-by-case basis by a highway permit. Specifically this may occur where an expressway traverses areas that are “suburban” in nature, has a 50 mph (80 km/h) design speed, and traverses abutting land with development that is not sufficient to warrant continuous frontage roads.. Such access must incorporate a design similar to that of a service drive as a future consideration.

6. Design. Design entrances for agricultural or residential purposes according to the criteria in the *Handbook for the Policy on Permits for Access Driveways to State Highways* (92 *Illinois Administrative Code* 550).



SERVICE DRIVE ADJACENT TO EXPRESSWAY
(Restricted Right-of-Way Conditions))

Figure 45-2.F

45-2.09(b) Entrances Other Than Agricultural or Residential

All land uses other than agricultural or single-dwelling residential are considered commercial. Direct access from commercial developments to an expressway is not permitted. The suburban access allowance may provide an occasional exception as noted in the previous section. Plan for indirect access to commercial properties via adjacent crossroads, service drives, or frontage roads.

45-3 OTHER DESIGN FEATURES

45-3.01 Lane Transitions

Careful consideration must be provided to the design of transitions from multilane facilities to two-lane facilities. These are complex decision-making areas for a driver who may not be expecting the lane reduction and lane shift. Therefore, decision sight distance should be provided to and throughout the transition area. When designing transitions, consider the following:

1. Transitions on Tangent. Desirably, lane transitions should be designed on a tangent section. This can be accomplished by the following:

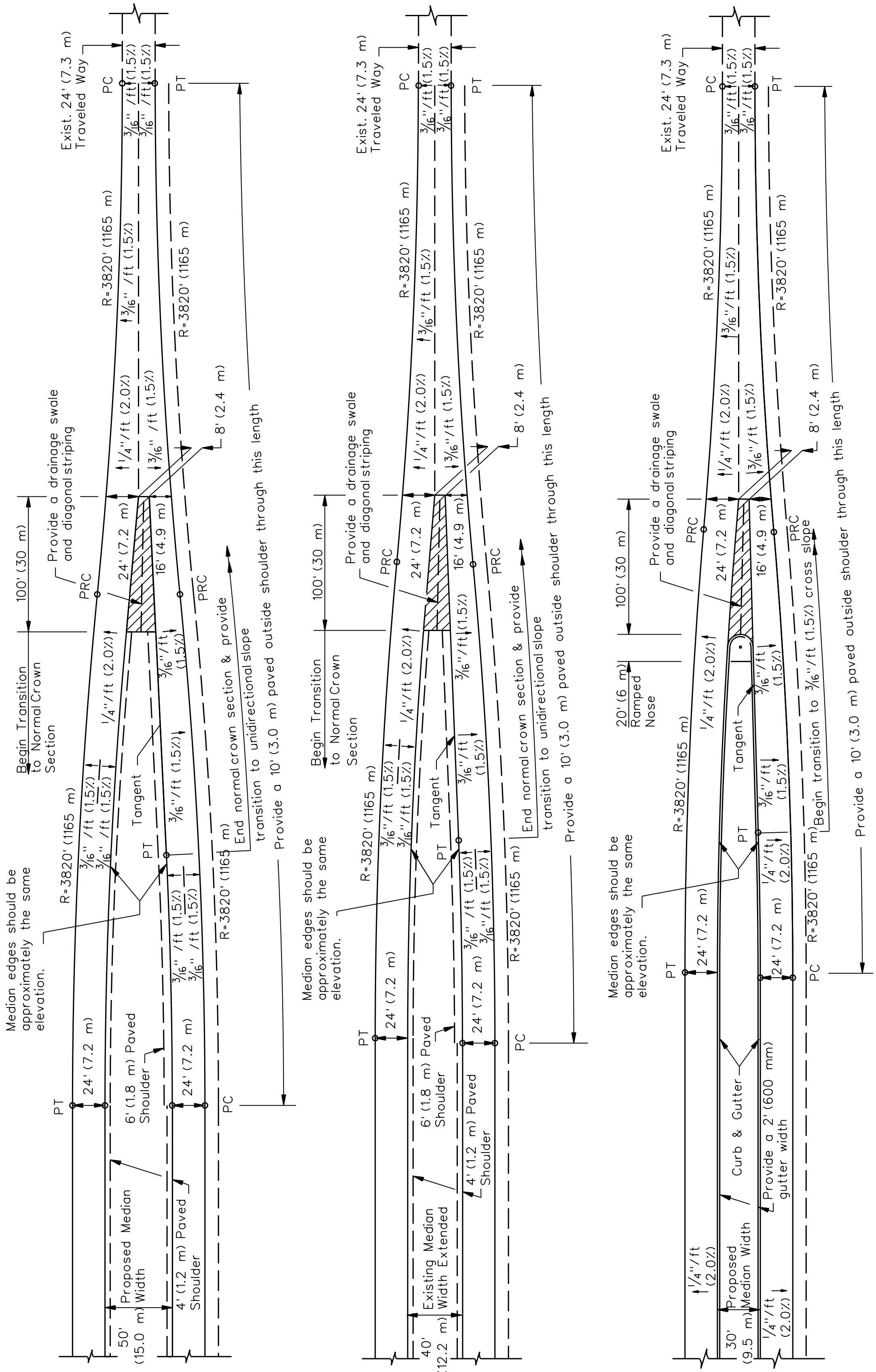
    a. Centered on Existing Roadway. Figure 45-3.A illustrates three designs for transitioning from four lanes to two lanes. The proposed pavements are centered about the centerline of the existing traveled way. The bottom drawing illustrates a transition to a raised-curb median, the middle drawing to an existing 40 ft (12.2 m) wide depressed median extended, and the top drawing to a proposed 50 ft (15 m) wide depressed median.

    b. Existing Roadway on Left. Figure 45-3.B provides three designs where the new roadway is added to the right of the existing roadway. The bottom drawing illustrates a transition to a raised-curb median, the middle drawing to an existing 40 ft (12.2 m) wide depressed median extended, and the top drawing to a proposed 50 ft (15 m) wide depressed median.

    c. Existing Roadway on Right. Figure 45-3.C provides three designs where the new roadway is added to the left of the existing roadway. The bottom drawing illustrates a transition to a raised-curb median, the middle drawing to an existing 40 ft (12.2 m) wide depressed median extended, and the top drawing to a proposed 50 ft (15 m) wide depressed median.

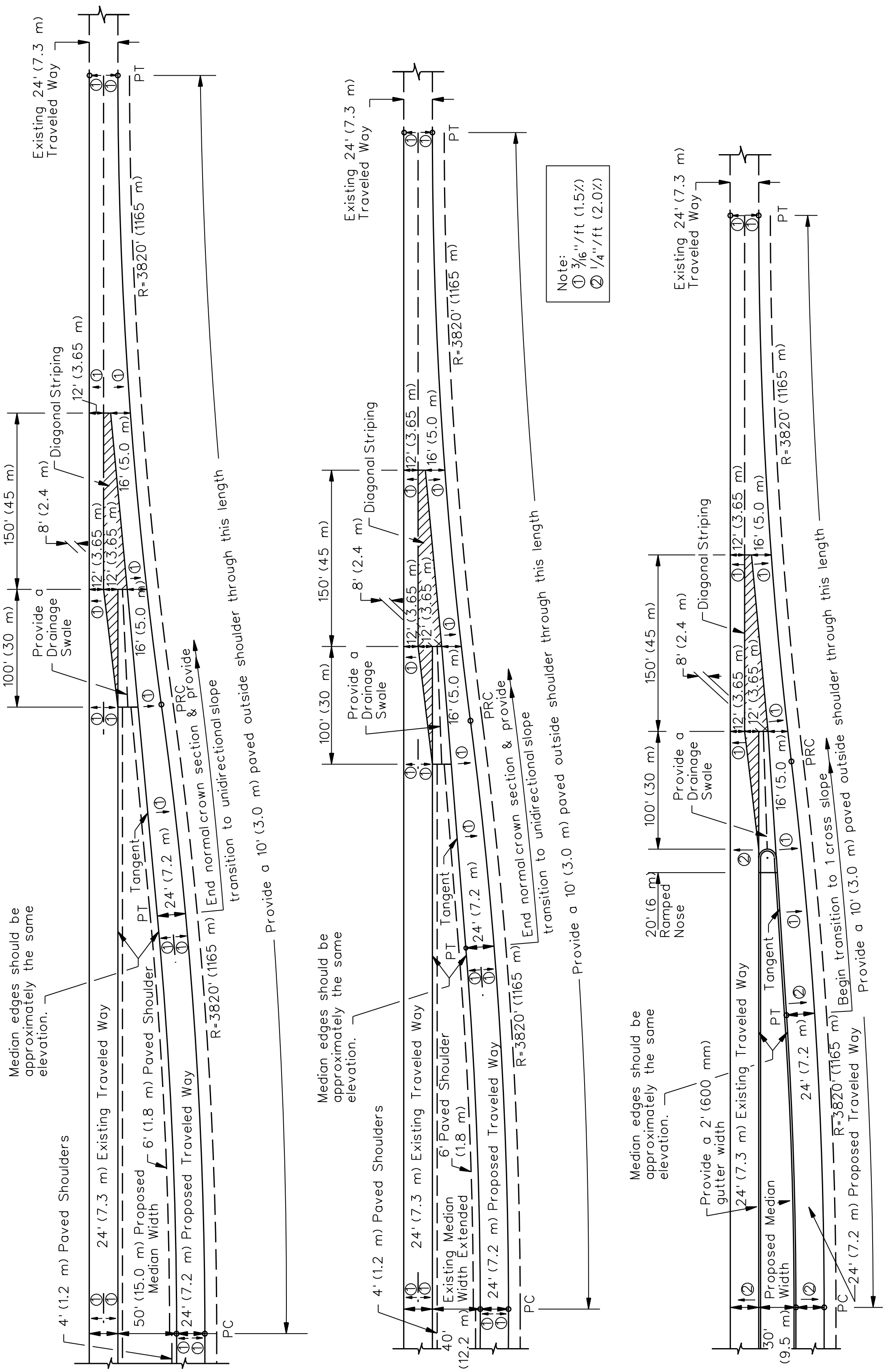
    d. Raised-Curb Median. In Figures 45-3.A, 45-3.B, and 45-3.C, the bottom drawings illustrate a transition to a 30 ft (9.5 m) raised-curb median. Only use this design where the design speed is 45 mph (70 km/h) or less.

    e. Transition Radii. At the design speed, a motorist can make a comfortable lane shift of 12 ft (3.6 m) in approximately three seconds of travel time. The transition design radii of 3820 ft (1165 m) shown in Figures 45-3.A, 45-3.B, and 45-3.C satisfies this criterion for all expressway design speeds; see Figure 45-3.D. With a 45 mph (70 km/h) design speed and restricted right-of-way, the reverse curves may be designed with a minimum radius of 2085 ft (620 m).



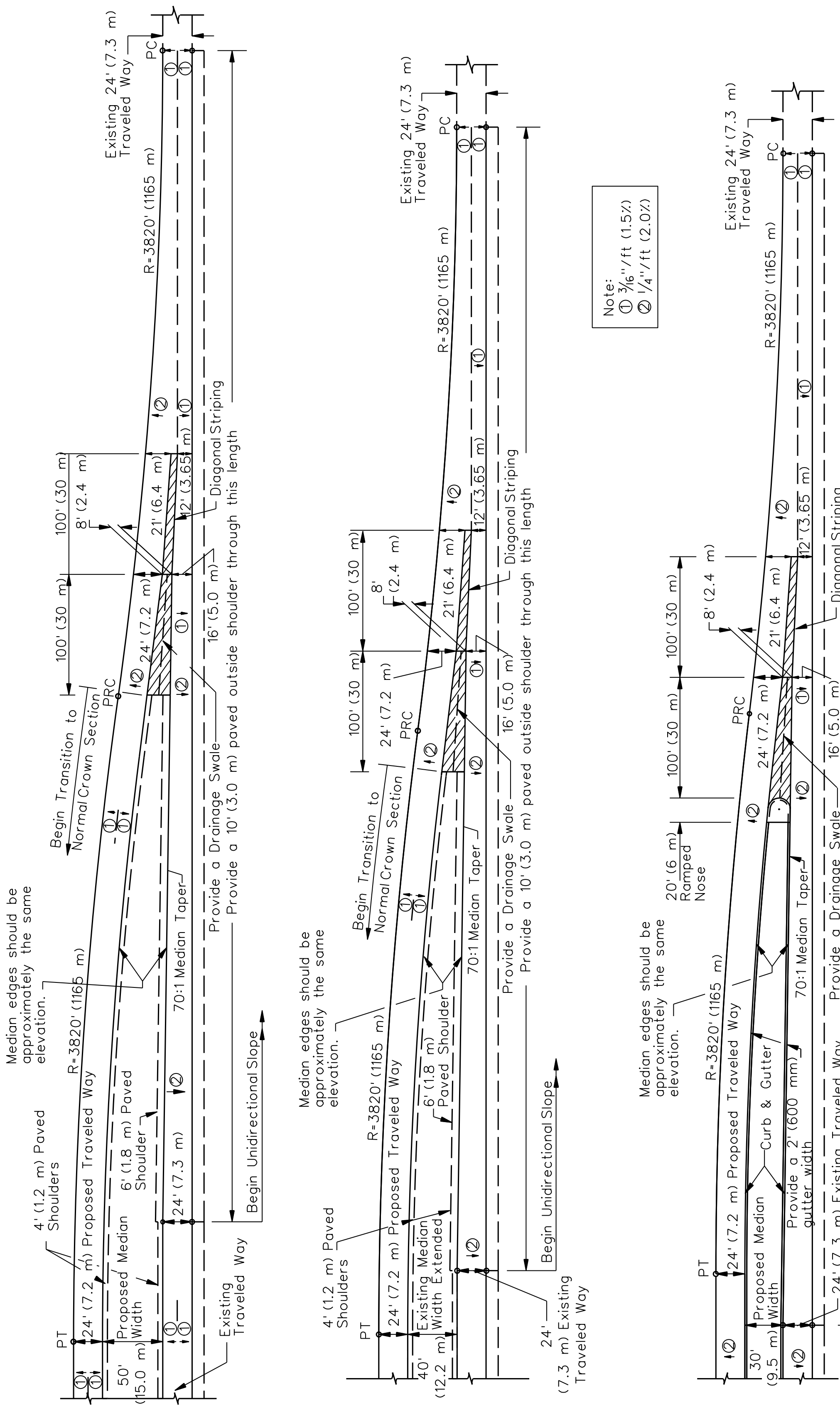
LANE TRANSITION DESIGNS ON TANGENT SECTION FROM FOUR TO TWO LANES
(Centered on Existing Traveled Way)

Figure 45-3.A



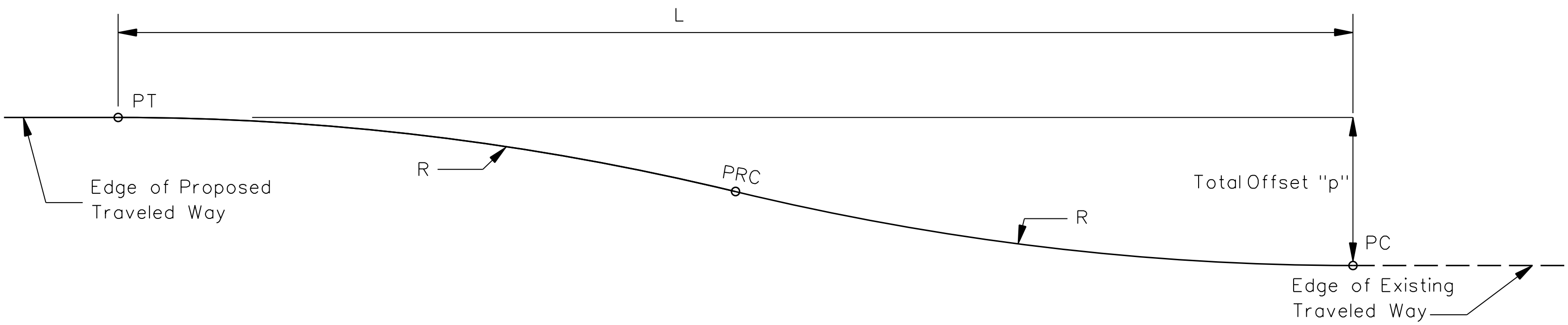
LANE TRANSITION DESIGNS ON TANGENT SECTION FROM FOUR TO TWO LANES (Existing Roadway on Left)

Figure 45-3.B



LANE TRANSITION DESIGNS ON TANGENT SECTION FROM FOUR TO TWO LANES
(Existing Roadway on Right)

Figure 45-3.C



$$L = \sqrt{4pR - p^2}$$

Where:
- L = Reverse curve length, ft (m)
- R = Radii of reverse curves, ft (m)
- p = Total offset, ft (m)

US Customary		Metric	
R = 3820 ft		R = 1165 m	
Total Offset "p" (ft)	Reverse Curve Length "L" (ft)	Total Offset "p" (m)	Reverse Curve Length "L" (m)
74	1060.78	22.20	320.872
64	986.83	19.40	298.502
54	906.75	16.70	278.465
37	750.99	11.05	226.651
32	698.52	9.65	211.893
27	641.74	8.30	196.492

LANE TRANSITIONS

Figure 45-3.D

2. Transitions on Curve. Where the transition is on a curve, the crossover crown line is an important design consideration. In going from two lanes to the separation of the lanes with a median, the crossover algebraic difference should be no greater than 5% for design speeds greater than or equal to 60 mph (100 km/h) and 6% for design speeds less than or equal to 55 mph (90 km/h).

   Figure 45-3.E illustrates an example of a curved-lane transition where the new roadway is added to the outside of an existing curve. Figure 45-3.F illustrates an example of a curved-lane transition where the new roadway is added to the inside of the curve.

45-3.02 Median Width Transitions

Figures 45-3.E and 45-3.F illustrate the geometric criteria for median width transitions. When designing median width transitions, consider the following:

1. Outside a Horizontal Curve. Where the added roadway for the proposed expressway is located on the outside of an existing horizontal curve, provide the alignment transition to the uniform median width on one end of the proposed horizontal curve only (i.e., either up or downstream). The alignment of the transition should be gradual unless intersections, critical right-of-way, etc., require a shorter transition to the project design median width.

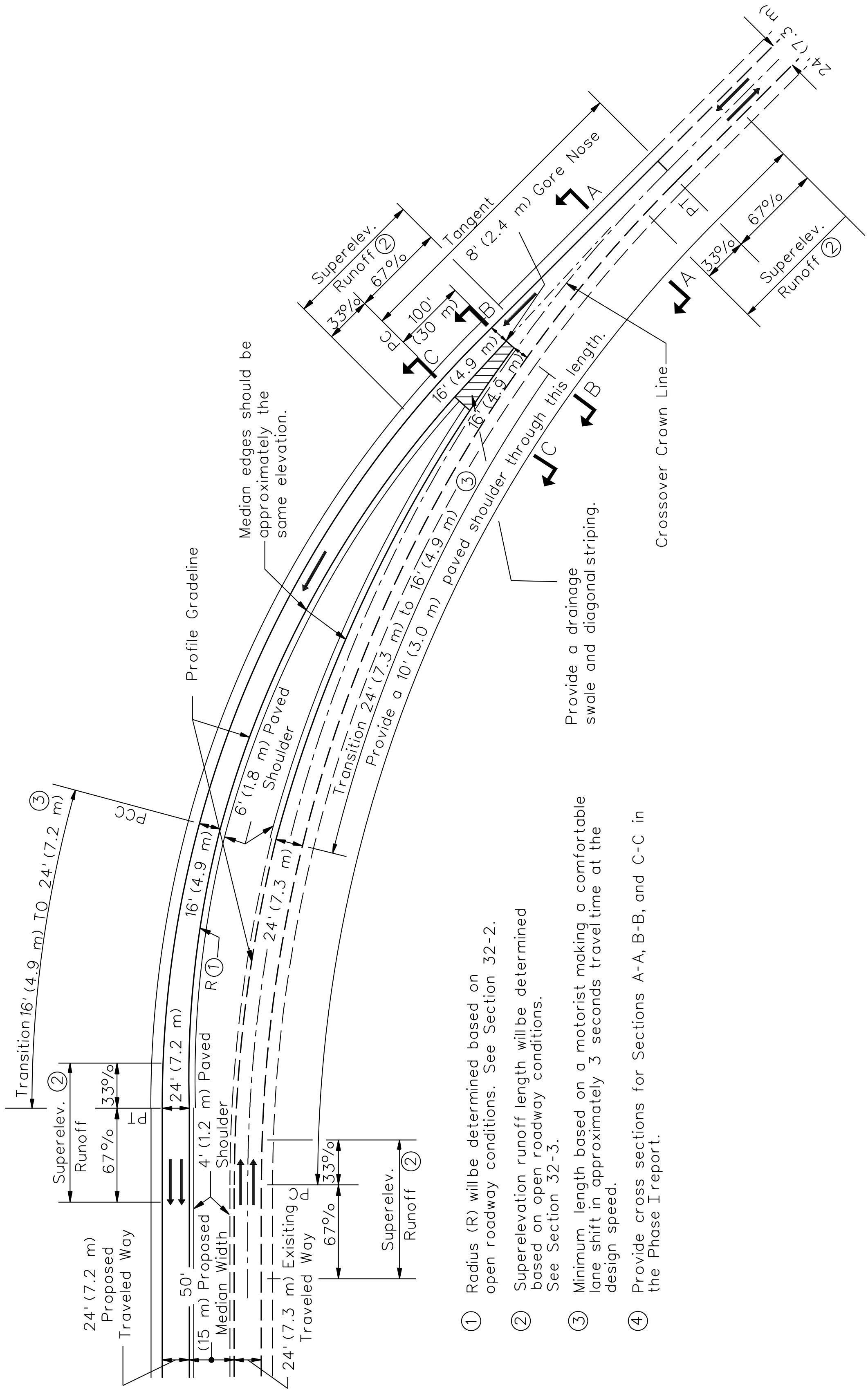
2. Inside a Horizontal Curve. Where the added roadway for the proposed expressway is located on the inside of an existing horizontal curve, design the proposed horizontal curve to fit into the back and forward tangents. This design may provide for a variable width median through the two adjacent horizontal curves.

45-3.03 Underdrains

Where there is a significant drainage problem, consider providing underdrains along an existing roadway or raising the elevation of the existing roadway to eliminate the drainage and stability problems.

45-3.04 Mailboxes

With typical 10 ft (3.0 m) wide right shoulders, separate mailbox turnouts will not be required along expressways. Place the mailbox post 2 ft (600 mm) minimum from the edge of the paved shoulder. Locating mailboxes such that they require the crossing of the expressway median by a pedestrian is discouraged; the issue may be addressed on a case-by-case basis.



① Radius (R) will be determined based on open roadway conditions. See Section 32-2.

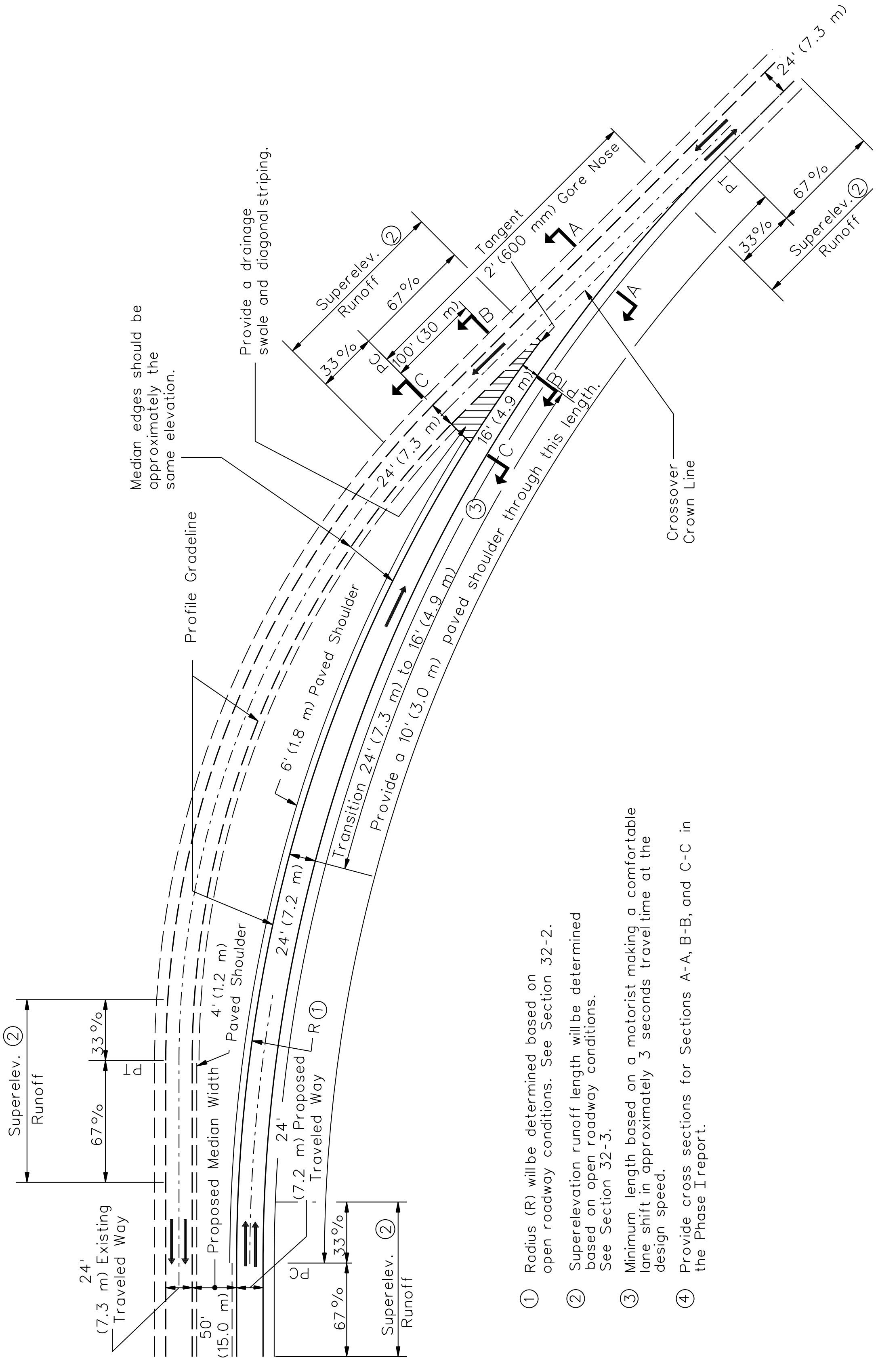
② Superelevation runoff length will be determined based on open roadway conditions. See Section 32-3.

③ Minimum length based on a motorist making a comfortable lane shift in approximately 3 seconds travel time at the design speed.

④ Provide cross sections for Sections A-A, B-B, and C-C in the Phase I report.

LANE TRANSITION DESIGN ON CURVE FROM FOUR TO TWO LANES
(New Roadway Outside)

Figure 45-3.E



① Radius (R) will be determined based on open roadway conditions. See Section 32-2.

② Superelevation runoff length will be determined based on open roadway conditions. See Section 32-3.

③ Minimum length based on a motorist making a comfortable lane shift in approximately 3 seconds travel time at the design speed.

④ Provide cross sections for Sections A-A, B-B, and C-C in the Phase I report.

LANE TRANSITION DESIGN ON CURVE FROM FOUR TO TWO LANES (New Roadway Inside)

Figure 45-3.F

45-4 TABLES OF DESIGN CRITERIA

Figures 45-4.A, 45-4.B, and 45-4.C present the Department's design criteria for expressway projects. Note that these figures also provide criteria for an existing roadway elements allowed to remain in place. The designer should realize that some of the cross section elements included in the figures (e.g., raised-curb median) are not automatically warranted in the project design. The values in the figures only apply after the decision has been made to include the element in the highway cross section.

Design Element				Manual Section	New Lanes (1a) One-Way DHV: Under 2400 (2)	Existing Lanes (1b) One-Way DHV: Under 2400 (2)
Design Controls	Design Forecast Year			31-4.02	20 Years	20 Years
	* Design Speed			31-2	70 mph **(3a)**	70 mph **(3b)**
	Access Control			35-1	Partial Control **(4)**	Partial Control **(4)**
	Level of Service			31-4.04	B	B
Cross Section Elements	* Traveled Way Width			34-2.01	2 @ 24′	2 @ 22′
	Shoulder Width	Right	Total Width	34-2.02	10′	8′
			Paved		10′	8′
		Left	Total Width		6′ **(5)**	4′
			Paved		4′	4′
	Auxiliary Lanes	Lane Width		37-2.05	12′	12′
		Shoulder Width			4′ (Paved)	4′ (Paved)
	Cross Slope	* Travel Lane		34-2.01	3/16″/ft for lanes adjacent to crown **(6)**	3/16″/ft for lanes adjacent to crown **(6)**
		Shoulder		34-2.02	1/2″/ft	1/2″/ft
	Median Width	Depressed		34-3	Minimum: 50′	Minimum: 40′ **(7)**
		Flush (Concrete Barrier)			22′ **(8)**	Minimum: 20′ **(8)**
	Clear Zone			38-3	**(9)**	**(9)**
Roadway Slopes	Side Slopes	Cut Section	Front Slope	34-4.03	1V:6H	1V:4H
			Ditch Bottom Width		4′ **(10)**	2′-0″ **(10)**
			Back Slope		1V:3H **(11)**	1V:3H **(11)**
		Rock Cut		34-4.05	—	—
		Fill Section		34-4.02	1V:6H to Clear Zone; 1V:3H max. to Toe of Slope **(12)**	1V:4H to Clear Zone; 1V:3H max. to Toe of Slope **(12)**
	Median Slopes			34-3	1V:6H	1V:5H
Bridges	New and Reconstructed Bridges	* Structural Capacity		N/A	HS-20	HS-20
		* Clear Roadway Width **(13)**		39-6	38′ - 40′	38′ to 40′
	Existing Bridges to Remain in Place	* Structural Capacity		N/A	HS-20	HS-20
		* Clear Roadway Width **(14a)**		39-6	36′ with 24′ Traveled Way **(14b)**	34′ with 22′ Traveled Way **(14b)**
	* Vertical Clearance (Expressway Under) **(15a)**	New and Replaced Overpassing Bridges **(15b)**		39-4	16′-6″	
		Existing Overpassing Bridges			16′-0″	
		Overhead Signs/ Pedestrian Bridges		33-5	New: 17′-3″ **(15b)**	Existing: 16′-9″
	* Vertical Clearance (Expressway over Railroad)			39-4.06	23′-0″	

* Controlling design criteria (see Section 31-8).

GEOMETRIC DESIGN CRITERIA FOR RURAL EXPRESSWAYS (New Construction/Reconstruction) (US Customary)

Figure 45-4.A

	Design Element			Manual Section	New Lanes (1a) One-Way DHV: Under 2400 **(2)**	Existing Lanes (1b) One-Way DHV: Under 2400 **(2)**
Design Controls	Design Forecast Year			31-4.02	20 Years	20 Years
	* Design Speed			31-2	110 km/h **(3a)**	110 km/h **(3b)**
	Access Control			35-1	Partial Control **(4)**	Partial Control **(4)**
	Level of Service			31-4.04	B	B
Cross Section Elements	* Traveled Way Width			34-2.01	2 @ 7.2 m	2 @ 6.6 m
	Shoulder Width	Right	Total Width	34-2.02	3.0 m	2.4 m
			Paved		3.0 m	2.4 m
		Left	Total Width		1.8 m **(5)**	1.2 m
			Paved		1.2 m	1.2 m
	Auxiliary Lanes	Lane Width		37-2.05	3.6 m	3.6 m
		Shoulder Width			1.2 m (Paved)	1.2 m (Paved)
	Cross Slope	*Travel Lane		34-2.01	1.5% for lanes adjacent to crown **(6)**	1.5% for lanes adjacent to crown **(6)**
		Shoulder		34-2.02	4%	4%
	Median Width	Depressed		34-3	Minimum: 15 m	Minimum: 12 m **(7)**
		Flush (Concrete Barrier)			7.0 m **(8)**	Minimum: 6.0 m **(8)**
	Clear Zone			38-3	**(9)**	**(9)**
Roadway Slopes	Side Slopes	Cut Section	Front Slope	34-4.03	1V:6H	1V:4H
			Ditch Bottom Width		1.2 m **(10)**	600 mm **(10)**
			Back Slope		1V:3H **(11)**	1V:3H **(11)**
		Rock Cut		34-4.05	—	—
		Fill Section		34-4.02	1V:6H to Clear Zone; 1V:3H max. to Toe of Slope **(12)**	1V:4H to Clear Zone; 1V:3H max. to Toe of Slope **(12)**
	Median Slopes			34-3	1V:6H	1V:5H
Bridges	New and Reconstructed Bridges	*Structural Capacity		N/A	MS-18	MS-18
		*Clear Roadway Width **(13)**		39-6	11.4 m - 12.0 m	11.4 m – 12.0 m
	Existing Bridges to Remain in Place	*Structural Capacity		N/A	MS-18	MS-18
		*Clear Roadway Width **(14a)**		39-6	10.8 m with 7.2 m Traveled Way **(14b)**	10.2 m with 6.6 m Traveled Way **(14b)**
	* Vertical Clearance (Expressway Under) **(15a)**	New and Replaced Overpassing Bridges **(15b)**		39-4	5.0 m	
		Existing Overpassing Bridges			4.9 m	
		Overhead Signs/ Pedestrian Bridges		33-5	New: 5.25 m **(15b)**	Existing: 5.1 m
	* Vertical Clearance (Expressway over Railroad)			39-4.06	7.0 m	

* Controlling design criteria (see Section 31-8).

GEOMETRIC DESIGN CRITERIA FOR RURAL EXPRESSWAYS
(New Construction/Reconstruction) (Metric)

Figure 45-4.A

(1) Design Criteria.

a. When upgrading an existing two-lane highway to a four-lane expressway, use the criteria in the new lanes column for the design of the new roadway and median.
b. The criteria in this column are the minimum cross-section elements allowed to remain in place for reconstruction of an existing roadway provided it is cost effective and safety record is satisfactory.

(2) Traffic Volumes. The design hourly volumes (DHV) are calculated assuming base conditions (except for 8% heavy vehicles) and a PHF = 1.0. Adjust these values using local factors. For volumes exceeding the listed DHV, use the *Highway Capacity Manual* to determine the applicable number of travel lanes.

(3) Design Speed.

a. In rolling terrain, a minimum design speed of 60 mph (100 km/h) may be considered with study and justification.
b. To determine the minimum design speed allowed to remain, see Section 45-2.02.

(4) Access Control. Bypasses around a community should be fully access controlled if the installation of traffic signals is likely at any intersection during the 20-year design period.

(5) Shoulder Width (Left). In most cases, left shoulders should be 6 ft (1.8 m) wide. This allows for the use of 1V:6H slopes in the median. However, if the 20-year level of service approaches Level C, then consider an 8 ft (2.4 m) wide left shoulder and decrease the median slopes to 1V:5H.

(6) Travel Lane Cross Slope. For each additional lane away from the crown lanes, increase the cross slope by 1/16″ /ft (0.5%) per additional lane up to a maximum of 5/16″ /ft (2.5%).

(7) Depressed Median Width. Median width based on 1V:5H median slopes and existing 2 ft (600 mm) ditch bottom width.

(8) Flush Median Width. In rural areas, only use flush medians with concrete barrier where right-of-way or topography restricts the use of a depressed median. Consider providing wider medians where required for snow storage.

(9) Clear Zone. The clear zone will vary according to design speed, traffic volumes, side slopes, and horizontal curvature. To achieve the proper clear zone for restricted right-of-way conditions, see Figure 34-4D.

(10) Ditch Bottom Width. Provide a wider outside ditch bottom where detention storage of storm water is a consideration.

(11) Back Slope. Where the height of cut exceeds 10 ft (3 m), consider using a 1V:2H back slope beyond the clear zone. Also, for heights greater than 30 ft (9 m), consider the use of benching.

(12) Fill Slope. For fill heights greater than 30 ft (9 m), use a 1V:2H uniform slope with a roadside barrier. Also, for heights greater than 30 ft (9 m), consider the use of benching.

(13) New and Reconstructed Bridge Widths. Clear roadway bridge widths are measured from face to face of parapets or rails. Bridge widths are normally defined as the sum of the approach traveled way width and the width of the paved shoulders.

GEOMETRIC DESIGN CRITERIA FOR RURAL EXPRESSWAYS
(New Construction/Reconstruction)

Footnotes Figure 45-4.A

(14) Existing Bridge Widths to Remain in Place.

a. Clear roadway bridge widths measured from face to face of parapets or rails. Implies elements allowed to remain in place without a design exception when cost effective and when safety record is satisfactory.
b. Bridges with total lengths greater than 250 ft (75 m) or any span longer than 120 ft (36 m) typically should have a clear roadway bridge width of 38 ft (11.4 m) or 40 ft (12.0 m).

(15) Vertical Clearance (Expressway Under).

a. The clearance must be available over the traveled way and any paved shoulder.
b. Table value includes allowance for future overlays.

GEOMETRIC DESIGN CRITERIA FOR RURAL EXPRESSWAYS
(New Construction/Reconstruction)

Footnotes Figure 45-4.A (Continued)

	Design Element			Manual Section	Construction (Ex-6) One-Way DHV: 4400 **(1)**	Reconstruction (Ex-6) One-Way DHV: 3700 **(1)**	Reconstruction (Ex-4) One-Way DHV: 2450 **(1)**
Design Controls	Design Forecast Year			31-4.02	20 Years	20 Years	20 Years
	*Design Speed			31-2	Minimum 60 mph **(2)**	Minimum 50 mph	Minimum 50 mph
	Access Control			35-1	Full Control **(3a)**	Partial Control **(3b)**	Partial Control **(3b)**
	Level of Service			31-4.04	C	C	C
Cross Section Elements	*Traveled Way Width			34-2.01	2 @ 36′	2 @ 36′ **(4a)**	2 @ 24′ **(4b)**
	Shoulder Width	Right	Total Width	34-2.02	10′	10′	10′
			Paved		10′	10′	10′
		Left	Total Width		10′	10′	6′
			Paved		10′	10′	4′
	Auxiliary Lanes	Lane Width		34-2.03	12′	12′	12′
		Shoulder Width			4′	4′	4′
	Cross Slope	*Travel Lane **(5a)**		34-2.01	3/16″/ft for lanes adjacent to crown	3/16″/ft for lanes adjacent to crown **(5b)**	3/16″/ft for lanes adjacent to crown **(5b)**
		Shoulder		34-2.02	1/2″/ft	1/2″/ft to 3/4″/ft	1/2″/ft to 3/4″/ft
	Median Width	Depressed		34-3	Minimum: 52′ **(6a)**	**(6b)**	Minimum: 44′ **(6c)**
		Flush (Concrete Barrier) **(7a)**			22′	22′ **(7b)**	22′ **(7b)**
		Raised-Curb		45-2.06	N/A	22′ - 30′ **(8)**	22′ - 30′ **(8)**
	Clear Zone			38-3	**(9)**	**(9)**	**(9)**
Roadway Slopes	Side Slopes	Cut Section	Front Slope	34-4.03	1V:6H	1V:6H	1V:6H
			Ditch Bottom Width **(10)**		4′	4′	4′
			Back Slope **(11)**		1V:3H	1V:3H	1V:3H
		Cut Section (Curbed)		34-4.04	1V:20H for 10′: 1V:4H to Top of Slope	1V:20H for 10′: 1V:4H to Top of Slope	1V:20H for 10′: 1V:4H to Top of Slope
		Rock Cut		34-4.05	—	—	—
		Fill Section **(12)**		34-4.02	1V:6H to Clear Zone; 1V:3H Max. to Toe of Slope	1V:6H to Clear Zone; 1V:3H Max. to Toe of Slope	1V:6H to Clear Zone; 1V:3H Max. to Toe of Slope
	Median Slopes	Depressed		34-3	1V:6H	1/2″/ft (Flush)	1V:5H
		Raised-Curb		45-2.06	N/A	3/16″/ft	3/16″/ft
Bridges	New and Reconstructed Bridges	*Structural Capacity		N/A	HS-20	HS-20	HS-20
		*Clear Roadway Width **(13)**		39-6	56′	56′	38′ - 40′
	Existing Bridges to Remain in Place	*Structural Capacity		N/A	N/A	HS-20	HS-20
		*Clear Roadway Width		39-6	N/A	**(14)**	**(14)**
	*Vertical Clearance (Expressway Under) **(15a)**	New and Replaced Overpassing Bridges **(15b)**		39-4	16′-6″	16′-6″	16′-6″
		Existing Overpassing Bridges			N/A	16′-0″ **(15c)**	16′-0″ **(15c)**
		Overhead Signs/ Pedestrian Bridges		33-5	New: 17′-3″ **(15b)** Existing: 16′-9″		
	*Vertical Clearance (Expressway over Railroad)			39-4.06	23′-0″		

* Controlling design criteria (see Section 31-8).

GEOMETRIC DESIGN CRITERIA FOR URBAN AND SUBURBAN EXPRESSWAYS (New Construction/Reconstruction) (US Customary)

Figure 45-4.B

Design Element				Manual Section	Construction (Ex-6) One-Way DHV: 4400 (1)	Reconstruction (Ex-6) One-Way DHV: 3700 (1)	Reconstruction (Ex-4) One-Way DHV: 2450 (1)
Design Controls	Design Forecast Year			31-4.02	20 Years	20 Years	20 Years
	* Design Speed			31-2	Minimum 100 km/h **(2)**	Minimum 80 km/h	Minimum 80 km/h
	Access Control			35-1	Full Control **(3a)**	Partial Control **(3b)**	Partial Control **(3b)**
	Level of Service			31-4.04	C	C	C
Cross Section Elements	* Traveled Way Width			34-2.01	2 @ 10.8 m	2 @ 10.8 m **(4a)**	2 @ 7.2 m **(4b)**
	Shoulder Width	Right	Total Width	34-2.02	3.0 m	3.0 m	3.0 m
			Paved		3.0 m	3.0 m	3.0 m
		Left	Total Width		3.0 m	3.0 m	1.8 m
			Paved		3.0 m	3.0 m	1.2 m
	Auxiliary Lanes	Lane Width		34-2.03	3.6 m	3.6 m	3.6 m
		Shoulder Width			1.2 m	1.2 m	1.2 m
	Cross Slope	*Travel Lane **(5a)**		34-2.01	1.5% for lanes adjacent to crown	1.5% for lanes adjacent to crown **(5b)**	1.5% for lanes adjacent to crown **(5b)**
		Shoulder		34-2.02	4%	4% to 6%	4% to 6%
	Median Width	Depressed		34-3	Minimum: 16.0 m **(6a)**	**(6b)**	Minimum: 13.2 m **(6c)**
		Flush (Concrete Barrier) **(7a)**			7.0 m	7.0 m **(7b)**	7.0 m **(7b)**
		Raised-Curb		45-2.06	N/A	7.0 m - 9.5 m **(8)**	7.0 m - 9.5 m **(8)**
	Clear Zone			38-3	**(9)**	**(9)**	**(9)**
Roadway Slopes	Side Slopes	Cut Section	Front Slope	34-4.03	1V:6H	1V:6H	1V:6H
			Ditch Bottom Width **(10)**		1.2 m	1.2 m	1.2 m
			Back Slope **(11)**		1V:3H	1V:3H	1V:3H
		Cut Section (Curbed)		34-4.04	1V:20H for 3.0 m: 1V:4H to Top of Slope	1V:20H for 3.0 m: 1V:4H to Top of Slope	1V:20H for 3.0 m: 1V:4H to Top of Slope
		Rock Cut		34-4.05	—	—	—
		Fill Section **(12)**		34-4.02	1V:6H to Clear Zone; 1V:3H Max. to Toe of Slope	1V:6H to Clear Zone; 1V:3H Max. to Toe of Slope	1V:6H to Clear Zone; 1V:3H Max. to Toe of Slope
	Median Slopes	Depressed		34-3	1V:6H	4% (Flush)	1V:5H
		Raised-Curb		45-2.06	N/A	1.5%	1.5%
Bridges	New and Reconstructed Bridges	*Structural Capacity		N/A	MS-18	MS-18	MS-18
		*Clear Roadway Width **(13)**		39-6	16.8 m	16.8 m	11.4 - 12.0 m
	Existing Bridges to Remain in Place	*Structural Capacity		N/A	N/A	MS-18	MS-18
		*Clear Roadway Width		39-6	N/A	**(14)**	**(14)**
	* Vertical Clearance (Expressway Under) **(15a)**	New and Replaced Overpassing Bridges **(15b)**		39-4	5.0 m	5.0 m	5.0 m
		Existing Overpassing Bridges			N/A	4.9 m **(15c)**	4.9 m **(15c)**
		Overhead Signs/ Pedestrian Bridges		33-5	New: 5.25 m **(15b)** Existing: 5.1 m		
	*Vertical Clearance (Expressway over Railroad)			39-4.06	7.0 m		

* Controlling design criteria (see Section 31-8).

GEOMETRIC DESIGN CRITERIA FOR URBAN AND SUBURBAN EXPRESSWAYS
(New Construction/Reconstruction) (Metric)

Figure 45-4.B

(1) Traffic Volumes. The design hourly volumes (DHV) are calculated assuming base conditions (except for 8% heavy vehicles) and a PHF = 1.0. Adjust these values using local factors. For volumes exceeding the listed DHV, use the *Highway Capacity Manual* to determine the number of travel lanes.

(2) Design Speed. With restricted urban conditions, a minimum design speed of 55 mph (90 km/h) may be considered with study and justification.

(3) Access Control.

- a. Where an expressway design has been extended from a rural area and is planned to bypass an urbanized area on new alignment, the bypass route should be developed with full control of access.
- b. Where an expressway design has been extended from a rural area through a developing urban area with restricted ROW, median crossovers according to Section 45-2.06. Signalized intersections also will exist and signal progression must be considered and investigated.

(4) Traveled Way Width. For existing pavements to remain, the following minimum widths will be allowed:

- a. Expressway Six Lanes (EX-6) — 2 @ 33 ft (10.0 m)
- b. Expressway Four Lanes (EX-4) — 2@ 22 ft (6.6 m)

(5) Travel Lane Cross Slope.

- a. For each additional lane away from the crown lanes, increase the cross slope by 1/16″ /ft (0.5%) per additional lane up to a maximum of 5/16″ /ft (2.5%).
- b. For raised-curb medians (proposed design speed ≤ 45 mph (70 km/h)) the cross slope of the two travel lanes adjacent to the median is 1/4″ /ft (2%) sloped away from the median. Where a third or outside lane is added to the traveled way in conjunction with a raised-curb median, the cross slope of the third lane will be 5/16″ /ft (2.5%).

(6) Depressed Median Width.

- a. Median width based on 10 ft (3.0 m) left shoulders, 1V:5H median slopes, 3 ft (900 mm) ditch depth, and 2 ft (600 mm) ditch bottom width.
- b. Right-of-way usually not available for a depressed median.
- c. Desirably, the median width should be 50 ft (15.0 m). The median width of 44 ft (13.2 m) is based on a 1V:5H median slope and 2 ft (600 mm) ditch bottom width.

(7) Flush Median Width.

- a. Provide a wider outside ditch where detention storage of storm water is a consideration.
- b. Where dual left-turn lanes are required, use a 30 ft (9.5 m) to 36 ft (10.5 m) wide median and provide a crashworthy end treatment on the CMB. See Figure 36-3M.

GEOMETRIC DESIGN CRITERIA FOR URBAN AND SUBURBAN EXPRESSWAYS
(New Construction/Reconstruction)

Footnotes Figure 45-4.B

(9) Clear Zone. The clear zone will vary according to design speed, traffic volumes, side slopes, and horizontal curvature. To achieve the proper clear zone for restricted right-of-way conditions, see Figure 34-4D.

(10) Ditch Bottom Width. Provide a wider outside ditch bottom where detention storage of storm water is a consideration.

(11) Back Slope. Where the height of cut exceeds 10 ft (3 m), consider using a 1V:2H back slope beyond the clear zone. Also, for heights greater than 30 ft (9 m), consider the use of benching.

(12) Fill Slope. For existing slopes to remain in place, see Figures 34-4A or 34-4B. For fill heights greater than 30 ft (9 m), use a 1V:2H uniform slope with a roadside barrier. Also, for heights greater than 30 ft (9 m), consider the use of benching.

(13) New and Reconstructed Bridge Widths. Assumes roadway approach adjacent to bridge has median shoulders. Clear roadway bridge widths are measured from face to face of parapets or rails. Bridge widths are normally defined as the sum of the approach traveled way width and the width of the paved shoulders. See Figure 39-5K for more information on urban bridges.

(14) Existing Bridge Widths to Remain in Place. Clear roadway bridge widths are measured from face to face of parapets or rails. Implies elements allowed to remain in place without a design exception approval when cost effective and when safety record is satisfactory. See Figures 39-5.A and 39-5.B.

(15) Vertical Clearance (Expressway Under).

a. The clearance must be available over the traveled way and any paved shoulders.
b. Table value includes allowance for future overlays.
c. A 15 ft 0 in (4.5 m) clearance may be used where an alternative route is available with a 16 ft 0 in (4.9 m) clearance.

GEOMETRIC DESIGN CRITERIA FOR URBAN AND SUBURBAN EXPRESSWAYS
(New Construction/Reconstruction)

Footnotes Figure 45-4.B (Continued)

Design Element		Manual Section	Design Speed 50 mph	55 mph	60 mph	70 mph
*Stopping Sight Distance **(1)**		31-3.01	425′	495′	570′	730′
Decision Sight Distance **(2)**		31-3.02	Urban: 1030′	Urban: 1135′	Rural: 990′ Urban: 1280′	Rural: 1105′
Intersection Sight Distance		36-6	—	—	—	—
*Minimum Radii	e_{max} = 6% **(3a)**	32-2.03	835	1065	1335′	Desirable: ≥ 3000′ Minimum: 2045′ **(3)**
	e_{max} = 8% **(3b)**		—	—	—	1815′ **(3b)**
*Superelevation Rate **(4)**		32-3	New: e_{max} = 6%		Reconstruction: e_{max} = 6% or 8%	
*Horizontal Sight Distance		32-4	**(5)**			
*Vertical Curvature (K-values)	Crest	33-4	84	114	151	247
	Sag		96	115	1367	181
*Maximum Grade	Level	33-2.02	New: 4% **(6a)**	New: 3% **(6a)**	New: 3% **(6a)**	New: 3% **(6b)**
	Rolling		New: 5% **(6a)**	New: 4% **(6a)**	New: 4% **(6a)**	New: 4% **(6b)**
Minimum Grade		33-2.03	Des: 0.5% Min: 0.3% (with Curb & Gutter) **(7)**	Des: 0.5% Min: 0.3% (with Curb & Gutter) **(7)**	Des: 0.5% Min: 0.3% (with Curb & Gutter) **(7)**	Des: 0.5% Min: 0.0% (with Special Ditching)

* Controlling design criteria (see Section 31-8)

(1) Stopping Sight Distance. Table values are for passenger cars on level grade.

(2) Decision Sight Distance. Table values are for the avoidance maneuver (speed/path/direction change).

(3) Minimum Radii.

a. An e_{max} of 6% may be used for both new and reconstruction projects.
b. In rural areas, existing horizontal curves with a maximum superelevation rate of 8% may remain if the radius is 1815 ft or more and there is no history of crashes.

(4) Superelevation Rate. See Section 32-3 for superelevation rates based on e_{max}, design speed, and radii of horizontal curves. For horizontal curves to remain in place, an e_{max} of 8% in rural areas and 6% in urban areas may be considered to remain in place. Where a crossroad intersection lies within the limits of an expressway horizontal curve, see Figure 36-1.E for the maximum superelevation rates allowed on the expressway.

(5) Horizontal Sight Distance. For a given design speed, the necessary middle ordinate will be determined by the radius of curve and the required sight distance.

(6) Maximum Grade.

a. Grades 1% steeper may be used for restricted conditions or to remain in place.
b. For existing roadways to remain, a maximum of a +4% on upgrades and -5% on downgrades may be retained.

(7) Minimum Grades. Where curb and gutter is required due to restricted right-of-way, use M-4.24 curb and gutter and locate it no closer than the outer edge of shoulder.

ALIGNMENT CRITERIA FOR EXPRESSWAYS (US Customary)

Figure 45-4.C

Design Element		Manual Section	Design Speed			
			80 km/h	90 km/h	100 km/h	110 km/h
*Stopping Sight Distance **(1)**		31-3.01	129 m	156 m	185 m	216 m
Decision Sight Distance **(2)**		31-3.02	Urban: 315 m	Urban: 360 m	Rural: 315 m Urban: 400 m	Rural: 330 m
Intersection Sight Distance		36-6	—	—	—	—
*Minimum Radii	e_{max} = 6% **(3a)**	32-2.03	252 m	336 m	437 m	Desirable: ≥ 1000 m Minimum: 560 m **(3)**
	e_{max} = 8% **(3b)**		—	—	—	505 **(3b)**
*Superelevation Rate **(4)**		32-3	New: e_{max} = 6%		Reconstruction: e_{max} = 6% or 8%	
*Horizontal Sight Distance		32-4	**(5)**			
*Vertical Curvature (K-values)	Crest	33-4	26	37	52	71
	Sag		30	37	45	54
*Maximum Grade	Level	33-2.02	New: 4% **(6a)**	New: 3% **(6a)**	New: 3% **(6a)**	New: 3% **(6b)**
	Rolling		New: 5% **(6a)**	New: 4% **(6a)**	New: 4% **(6a)**	New: 4% **(6b)**
Minimum Grade		33-2.03	Des: 0.5% Min: 0.3% (with Curb & Gutter) **(7)**	Des: 0.5% Min: 0.3% (with Curb & Gutter) **(7)**	Des: 0.5% Min: 0.3% (with Curb & Gutter) **(7)**	Des: 0.5% Min: 0.0% (with Special Ditching)

* Controlling design criteria (see Section 31-8)

(1) Stopping Sight Distance. Table values are for passenger cars on level grade.

(2) Decision Sight Distance. Table values are for the avoidance maneuver (speed/path/direction change).

(3) Minimum Radii.

a. An e_{max} of 6% may be used for both new and reconstruction projects.
b. In rural areas, existing horizontal curves with a maximum superelevation rate of 8% may remain if the radius is 502 m or more and there is no history of crashes.

(4) Superelevation Rate. See Section 32-3 for superelevation rates based on e_{max}, design speed, and radii of horizontal curves. For horizontal curves to remain in place, an e_{max} of 8% in rural areas and 6% in urban areas may be considered to remain in place. Where a crossroad intersection lies within the limits of an expressway horizontal curve, see Figure 36-1.E for the maximum superelevation rates allowed on the expressway.

(5) Horizontal Sight Distance. For a given design speed, the necessary middle ordinate will be determined by the radius of curve and the required sight distance.

(6) Maximum Grade.

a. Grades 1% steeper may be used for restricted conditions or to remain in place.
b. For existing roadways to remain, a maximum of a +4% on upgrades and -5% on downgrades may be retained.

(7) Minimum Grades. Where curb and gutter is required due to restricted right-of-way, use M-10.60 curb and gutter and locate it no closer than the outer edge of shoulder.

ALIGNMENT CRITERIA FOR EXPRESSWAYS
(Metric)

Figure 45-4.C

45-5 REFERENCES

1. *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2018.

2. NCHRP Report 375, *Median Intersection Design*, TRB, 1995.

3. *Highway Safety Design and Operations Guide*, AASHTO, 1997.

4. *Flexibility in Highway Design*, FHWA 1997.

5. *Roadside Design Guide, AASHTO,2011*